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Abstract

Purpose – This paper furthers research into the potential contribution of pollutant databases for corporate accountability by evaluating the quality of corporate and government mercury reporting via the Australian National Pollutant Inventory (NPI). The NPI underpins Australia's reporting under the Minamata Convention, a global agreement to reduce mercury pollution.

Design/methodology/approach – The qualitative characteristics of accounting information are used as a theoretical frame to analyse ten interviews with thirteen interviewees as well as 54 submissions to the 2018 governmental inquiry into the NPI.

Findings – While Australian mercury accounting using the NPI is likely sufficient to meet the expected Minamata reporting requirements (especially in relation to developing countries), we find significant limitations in relation to comparability, accuracy, timeliness and completeness. These limitations primarily relate to government (as opposed to industry) deficiencies, caused by insufficient funding. This suggests that multiple factors are required to realise the potential of pollutant databases for corporate accountability, including appropriate rules, ideological commitment and resourcing.

Practical Implications – The provision of additional funding would enable the NPI to be considerably improved (for mercury as well as other pollutants), particularly in relation to the measurement and reporting of emissions from diffuse sources.

Originality / Value – Whilst there have been prior reviews of the NPI, none have focused on mercury, whilst conversely prior studies which have discussed mercury information have not focused on the NPI. In addition, no prior NPI studies have utilised interviews nor have engaged directly with NPI regulators. There has been little prior engagement with pollutant databases in SEA research.

Keywords: Mercury, National Pollutant Inventory, databases, mandatory reporting

1. Introduction

Overwhelmingly, the study of social and environmental accounting (SEA) has been the study of corporate reporting via some kind of sustainability accounts (Deegan, 2013; Gray, 2005; Guthrie and Parker, 2017; Moses *et al.*, 2020). The development of this field has been to delve deeper and deeper into both the nature and process of such reporting, with recent studies examining specialised reporting domains such as carbon (Bebbington and Larrinaga, 2014; Haslam *et al.*, 2014), water (Hazelton, 2015; Tello *et al.*, 2016) and biodiversity (Samkin *et al.*, 2014; Tregidga, 2013).

Scholars have expressed both conceptual and empirical reservations, however, as to the utility of corporate sustainability reporting in terms of driving organisational change. Conceptually, the boundaries of sustainability accounts do not readily align with environmental boundaries (Gray, 2010; Gray and Milne, 2004), and notions of materiality are problematic (Canning *et al.*, 2018), particularly given the tension between the aggregated nature of sustainability accounts and the local interests of communities affected by corporate actions. Empirically, research reveals sustainability reports to be agents of propaganda rather than accountability (Cho, Freedman, *et al.*, 2012; Cho, Guidry, *et al.*, 2012; Cho *et al.*, 2010).

The current study continues the tradition of increased specialisation within SEA research by considering a single pollutant – mercury – but does so in a novel reporting setting – the Australian National Pollutant Inventory (NPI) database. The study of mercury pollution is important as mercury is one of the world's most toxic substances (ATSDR, 2001), and is the focus of the world's most recent multilateral environmental agreement: the Minamata Convention (UNEP, 2013b). Whilst mercury reporting is only one aspect of governance under the Minamata Convention, and we consider only on information source (the NPI), studying mercury reporting via a pollutant database is nevertheless important. Leong and Hazelton (2019) suggest that databases offer a promising avenue for corporate accountability: by offering the ability to meaningfully compare the performance of different firms, they facilitate both regulatory and community scrutiny of poor performers, and hence could be an important mechanism for mercury reduction.

We seek to make two contributions to the literature. First, we respond to calls for more relevant SEA research (Guthrie and Parker, 2016, 2017) by evaluating the extent to which the NPI enables Australia to comply with its reporting obligations under the Minamata Convention. We show that whilst Australian mercury reporting may be better than that of many developing nations, there is considerable room for improving the comparability, accuracy, timeliness and completeness of mercury information (and information related to other pollutants). Somewhat surprisingly, we find that these limitations are due more to government inaction than corporate malfeasance; the root cause is a lack of funding, a topic largely absent from prior literature. Second, we contribute to the emerging discussion within SEA regarding how databases might promote greater accountability. Our findings suggest that a number of factors need to be in place in order for the potential of databases to be realised, including formal mechanisms for accounting (i.e. disclosure rules), informal mechanisms (the 'hearts and minds') and adequate resourcing.

The remainder of the paper is structured as follows. Section 2 provides the background and context of the study. Section 3 reviews relevant literature and Section 4 delineates the theoretical framework of the study. Section 5 outlines the methods of the study, Section 6 provides findings and Section 7 offers conclusions, limitations and further research directions.

2. Background and Context

This section provides the context of the study in two parts. First, the case for the global importance of mercury is provided, via reference to various toxicity-related research, which has culminated in the establishment of the Minamata Convention. Second, the main mechanism for reporting on mercury in Australia, the National Pollutant Inventory, is described.

2.1 The importance of mercury and the Minamata Convention

Mercury is one of the most toxic elements known to humanity. Mercury is considered the third most hazardous substance in the world, after arsenic and lead (ATSDR, 2001) and a "priority metal" in terms of public health significance (Tchounwou *et al.*, 2014, p. 133). Mercury cannot be converted into a non-toxic substance (UNEP, 2011). Scientists began to understand the severe toxic effect of mercury in the 1950s after the Minamata incident, in which more than 2,200 people suffered mercury poisoning (Yorifuji *et al.*, 2012). Mercury can exist in multiple forms (WHO, 2017): elemental (i.e. the liquid substance of mercury), inorganic (e.g. mercury vapour) and organic (e.g. methylmercury, to which people may be exposed to in their diet). Methylmercury is especially neurotoxic (Bjornberg *et al.*, 2003) but all types of mercury are harmful to the nervous system, and high-level exposure can cause damage to the kidney, brain, and foetus (NPI, 2014; Valera *et al.*, 2011). The impact of mercury on the brain can negatively affect vision, hearing, and memory and cause tremors and irritability (NPI, 2014). The children of mothers exposed to mercury may have negative impacts on their reasoning and intellect, language and academic achievement (Crump *et al.*, 1998). Mercury can harm the human nervous system and damage the kidneys, lungs, hearing, memory, and babies in the womb (NPI, 2014).

Mercury exposure may occur through multiple pathways but is typically ingested via plants grown in contaminated soil or other food which contains mercury (Axelrad *et al.*, 2007). In particular, methylmercury can be incorporated and bio-magnified in organisms in the food chain (NRC, 2000; UNEP, 2011) and is highly related to diets consisting of particular freshwater fish and seafood including trout and pike from lakes and tuna and shark from the seas (USEPA, 1997; Weihe *et al.*, 2005). For example, Økelsrud *et al.* (2016) note that mercury concentration in fish above EU and Norwegian limits have been found in several Norwegian lakes. High Mercury levels have also been reported in fish in Swedish lakes. Furthermore, Økelsrud *et al.* (2017) report that despite lower mercury emissions in Scandinavia for a number of years, mercury concentrations in some fish in certain lakes have increased.

Mercury emissions stem from a wide range of sources and are transboundary. Emission sources include coal combustion (Selin and Selin, 2006), gold mining, lamps, switches, medical equipment, wastages, batteries, fossil fuel, dental amalgam and cement (AMAP/UNEP, 2013; USEPA, 2014). Mercury emissions from one country may spread to others via air or water (Rahman, 2011), and due to the global nature of food supply, mercury exposure may occur from eating food which was contaminated thousands of kilometres away.

The Minamata Convention is an effort to address mercury pollution in a globally coordinated way, and provides further evidence of deep and widespread concern regarding mercury pollution. Given the transboundary nature of mercury pollution, national and even regional agreements have been largely unsuccessful in curbing emissions (Selin and Selin, 2006). The

United Nations has therefore facilitated a global approach to address mercury pollution, and the Minamata Convention represents the culmination of these efforts (Selin, 2013). Governments were first invited to sign the Convention in 2013, and it came in to force on 16 August 2017 (UNEP, 2018). The Convention has now been signed by 128 countries (including Australia) and ratified by 121 countries.

The Convention encompasses both national action and reporting on mercury. In terms of actions, the Convention includes measures to reduce mercury production (such as banning new mercury mines and phasing out current mining), use (by reducing mercury usage in processes and products), and emissions (by introducing control measures for air, land and water releases), as well as mercury storage, disposal and the remediation of contaminated sites (UNEP, 2018). In addition to mercury reduction measures, the Minamata Convention has extensive reporting requirements. Each party must report to the Conference through the Secretariat on the actions it has adopted and the effectiveness of those steps in accomplishing the ultimate goal of the Convention [Article 21]. Parties are expected to provide information, where relevant, on (a) mercury supply [Article 3]; (b) mercury import and export [Article 3]; (c) production, supply in commerce and trade of mercury-added goods [Annex A]; (d) steps taken to phase out mercury-added products and amount already reduced; (e) evidence of development in reducing and eradicating, atmospheric emissions and releases [Articles 8 and 9]; (f) financial and technical supports [Articles 13 and 14]; (g) evaluations of the improvements of implementation plan [Article 15]; (h) progress report on implementation plan; and (i) other data or reports as required by the Convention (UNEP, 2013b). This data is not only important in evaluating progress on implementing the Minamata Convention within particular countries but also in addressing potentially illegal trade. The 2017 UN Environment report on global mercury supply and trade documents large deviations in export and import data for mercury between countries (UN Environment, 2017, pp. 25-26), and better quality reporting would allow evaluation of whether these discrepancies were due to deficiencies in reporting, or indicated illegal mercury trading requiring intervention.

2.2 The Australian Context

Australia provides a useful research setting as it is a significant mercury emitter on a per capita basis (Ippolito *et al.*, 2012). Whilst the Australian region (Australia, New Zealand and Oceania) contributed only 0.4% of global emissions (UN Environment, 2019, p. 12), in absolute Australia is nonetheless one of the top ten anthropogenic mercury emitting countries (AMAP/UNEP, 2008). Recent UN estimates (AMAP/UNEP, 2019, pp. 3.14-3.15) are that Australian mercury air emissions in 2015 were 7,672kg, which is significantly higher than comparable emissions by Canada (4,021kg), similar to that of South Korea (6,948kg) and half that of Japan (15,007kg), though all these emissions are dwarfed by China (565,244kg). Globally, UN Environment (2019, p. 12) estimate that the majority of air emissions occurred in Asia (49%, of which 39% are from East and South-east Asia), followed by South America (18%) and Sub-Saharan Africa (16%).

In addition to having significant per-capita emissions, Australia is a developed country with a national pollution reporting mechanism – the NPI - that has been in place since 1998. Given these resources, it would be expected that Australia would be among the leaders in reporting mercury emissions, and if deficiencies exist this may indicate that other, potentially more serious, limitations exist in other regions. The Australian NPI is broadly equivalent to other pollutant release and transfer registers such as the Pollutant Inventory of the United Kingdom,

National Pollutant Release Inventory of Canada, Toxics Release Inventory of the US and European Pollutant Release and Transfer Register.[1] These registers have a number of purposes: as well as facilitating compliance with reporting of international agreements, they also act as catalysts for change by alerting governments, citizens and corporate managers of toxic emissions (Howes, 2001, pp. 530-531). This role is discussed further in the following section.

Australia signed the Minamata Convention on 10 October 2013, which as noted above entails emission reduction activities and reporting obligations (the focus of this paper) which rely on NPI data. Half of Australian mercury emissions are from industrial point sources (particularly power generation, mining, aluminum, and refineries) with the remaining from diffuse sources (NPI, 2008 cited in Dutt *et al.*, 2009). Both point and diffuse source Australian mercury information is collected through the NPI, which was established in 1998 to capture and publicly report emissions of 93 pollutants. Pollutant data is collected by state and territory governments, with funding provided by the Australian Government, and entered into the NPI database.

The NPI database contains emission data from both point sources (i.e., facilities such as power plants, mines or smelters) and diffuse sources (i.e., aggregate discharges from lamps, switches, thermometers, and batteries). Point source emissions are estimated by facilities using Emission Estimation Technique (EET) manuals that provide industry-specific guidelines for emission estimation based on production volumes and other variables. Facilities must submit their reports by 30 September for the preceding year ended either 30 June or 31 December. State and territory environment agencies evaluate the reports and then forward this data to the Australian Government by 28 February, and the Australian Government publishes the data on 31 March. Aggregated emissions data from diffuse sources are measured and reported by respective state and territory governments. The scope and timing of this measurement are at the discretion of the state and territory governments and are usually less frequently than the point sources emission. Diffuse emissions estimation technique manuals are used to determine consistent emission data among states and territories. Once this data is obtained, it is sent to the Australian government for formatting and is then included in the NPI at the next publication date. In addition to information being provided on the online database, an annual report which includes information about the NPI is published by the National Environment Protection Council. Information in this report includes such matters as the number of companies subject to audit or review in relation to their NPI submissions, discussed further in section 6.4.

The Australian NPI was subject to a review in 2018, the details of which are discussed in section 5. To date, no changes have been made to the operation of the NPI. One reason for the delay is that a review of the overarching environmental regulation is currently underway – the *Environment Protection and Biodiversity Conservation Act* 1999. In relation to pollution, this Act governs not only reporting but also emissions, and the review may also seek to change the sharing of environmental authority and responsibilities between the Commonwealth and the States and Territories (Power, Undated).

3. Literature Review

This section reviews the relevant literature in two parts: first, literature concerning environmental databases is reviewed, followed by studies that have considered mercury reporting. While we are not aware of any previous studies which specifically focus on mercury accounting, previous studies on mercury which have commented on the issues of mercury accounting and reporting have identified numerous issues regarding the quality of mercury

information. This literature therefore raises concerns as to whether the Australian NPI mercury reporting process is adequate for meeting its international obligations.

3.1 Environmental databases

Following generalist reviews of environmental accounting (Mathews, 1997), authors such as Deegan and Rankin (1997) and Guthrie and Parker (1990) have called for narrower social and environmental accounting research. More recently, there have been calls for studies that contribute to the key challenges of sustainability and sustainable development (Bebbington and Unerman, 2018; Unerman and Chapman, 2014) as well as calls for accounting research with more practical application (Guthrie and Parker, 2017). In response, researchers have increasingly focused on specific environmental challenges such as carbon (Bebbington and Larrinaga, 2014; Haslam *et al*., 2014), water (Hazelton, 2015; Tello *et al*., 2016) and biodiversity (Samkin *et al*., 2014; Tregidga, 2013), though no previous research has been conducted on mercury accounting.

The consistent finding from both broad and narrow reviews of corporate sustainability reporting has been low levels of reporting quality, which has led to multiple calls for the imposition of mandatory reporting. Numerous studies have shown not only poor reporting, but reporting which is misleading, in that corporate reporting negatively correlated with performance (Cho, Freedman, *et al*., 2012; Cho, Guidry, *et al*., 2012; Cho *et al*., 2010). Consequently, for many years there have been calls for sustainability reporting to be regulated with similar (or greater) vigor as financial accounting (Adams and Zutshi, 2004; Gray and Milne, 2004).

In addition to studies of the *subjects* of environmental reporting, there have also been calls for greater research on the *mechanisms* for environmental reporting. Scholars have pointed out that the locus of corporate reporting entities, based on legal form, is rarely equivalent to the locus of environmental issues, meaning that there is a mismatch of reporting boundaries (Gray, 2010; Gray and Milne, 2004). In response, efforts have been made to examine alternate means of reporting social and environmental information, such as via 'full cost' reporting which internalise externalities or providing counter-narratives to narrowly focused corporate reports via 'shadow' accounts (Antheaume, 2007; Dey, 2007).

One such environmental reporting mechanism recently highlighted in the accounting literature is the central database. According to Leong and Hazelton (2019), a central database has the potential to create organisational change, primarily due to the inter-firm comparability that this mechanism facilities. By enabling the ranking of the performance of a large number of firms, databases facilitate what Fung and O'Rourke (2000, p. 120) term "maxi-min" – the maximum degree of regulatory and/ or community attention being applied to the minimum number of recalcitrant firms, which creates the best possible conditions for organisational change. Stephan (2002) provides a more detailed theoretical account of how databases facilitate change, listing five important benefits they provide: reduced information costs for users; the capacity to create shock/dread (for the public) and shame/fear (for reporters); enabling "maxi-min" regulation and facilitating agenda setting by both governments and citizens. Databases may also address the reporting boundary issue by requiring granular levels of disclosure – such as by individual facility – which can then be aggregated to match the environmental issue of concern, as opposed to an arbitrary legal form. Further, the disaggregated nature of reporting can mean that

materiality – long contentious in the realm of sustainability reporting (Canning *et al.*, 2018) – can be set low enough at an individual reporting level to satisfy users.

The potential role of databases in causing organisational change is supported by a small but encouraging literature. Fung and O'Rourke (2000) showed the role of US Toxic Release Inventory (TRI) information in warning various social groups about the worst environmental performers, which could then be used to create pressure for change. Hess (2007) also examined US transparency programs, including the TRI, and claimed that information reporting to different social groups can play a role as an emerging governance form in ensuring stakeholder accountability. Similarly Garcia *et al.* (2007) examined the efficiency of the Indonesian Program for Pollution Control Evaluation and Rating (PROPER), the first leading public reporting database in the developing world, and found a positive response to PROPER through emission reduction, particularly for firms with weak environmental compliance histories. In a Spanish context, Cañón-de-Francia *et al.* (2008) found that firms polluting above the reporting threshold, and therefore reporting under the European Pollutant Emissions Register regime, were 'punished' in terms of stock price, and that investors further discounted those companies who reported the highest levels of pollution.

Not all studies have reported positive results, however, which may be due to poor database design and/or operation. For example, Atlas (2007) suggested that the TRI was ineffective in improving the knowledge of people exposed to polluting industries. Gerde and Logsdon (2001) evaluated four comprehensive databases available in the US, identified the strengths and weaknesses of the databases, and suggested a number of areas where the quality and quantity of environmental performance data could be improved, most notably highlighting the lack of linkage between point source releases and the actual exposure rates of citizens and the lack of reporting by US firms of their international environmental performance.

Of particular relevance to this study are prior reviews of the quality of reporting under the NPI, which have taken a variety of approaches. International comparisons were undertaken by Burritt and Saka (2006) and Howes (2001). Burritt and Saka (2006) performed a desktop review of six pollutant databases (Australia, Canada, Japan, the Netherlands, the UK, and the USA), assessing the extent to which they accord with the then International Accounting Standards Committee qualitative characteristics of accounting information. Howes (2001) had 33 students compare the usefulness of the NPI and the US TRI databases via a survey. Zuo and Wheeler (2019) also conducted a survey, and in 2013 obtained data from 132 NPI stakeholders focused on various dimensions of quality of the NPI. Lloyd-Smith (2008) provides a history of the development of the NPI and an analysis of its strengths and weaknesses in relation to the views of stakeholders expressed during the NPI's gestation and operation. Finally, three studies examine specific use cases of the NPI to comment on the adequacy of the regime: Kolominskas and Sullivan (2004) explore NPI reporting by a fertiliser manufacturing facility; Tang and Mudd (2015) examine the case of emissions by Australian power stations, and Cooper *et al.* (2017) review reporting by the largest point source and diffuse sources of lead (Mount Isa Mines and unpaved roads respectively).

The prior studies of the NPI raised particular concerns regarding comparability, accuracy and completeness of NPI data. Whilst many of these studies predate the Minamata Convention, given that there have been few changes to the NPI since inception they remain pertinent. In relation to comparability, Cooper *et al.* (2017) found that facility estimation methods changed frequently and were inconsistent with methods adopted by similar facilities. Tang and Mudd (2015) found that non-reported calculation methods and production levels prevented

comparison with equivalent domestic and international facilities. Almost two thirds (63%) of respondents to the survey by Zuo and Wheeler (2019) called for nationally consistent measurement methods to be adopted. The need for greater contextual information was also reported by Howes (2001).

In relation to accuracy, Cooper *et al.* (2017) found significant differences between lead emissions calculated using the estimation manuals and those directly measured. Kolominskas and Sullivan (2004) suggested that manuals could be poor predictors of individual faculty performance and noted that poor estimation manuals not only stymied regulatory oversight but also corporate improvement. Over two-thirds (68%) of respondents to the survey by Zuo and Wheeler (2019) called for more robust estimation methods. Estimation accuracy was also called into question in relation to diffuse emissions: Cooper *et al*. (2017) found that the estimation manuals for diffuse source lead emissions were out of date, and that the most recent study of diffuse emissions was over a decade old.

Studies have also raised concerns regarding completeness of NPI data. Both Lloyd-Smith (2008) and Burritt and Saka (2006, p. 391) point out that the NPI covers far fewer substances (93) than international equivalents in the USA (667) and Japan (354). The NPI has also been criticised for ignoring appeals from a range of stakeholders for incorporating data relating to pesticides, chemical storage and emergency response plans (Lloyd-Smith, 2008). Howes (2010, pp. 531-534) notes that the development of the NPI was laborious, occurring over an eight-year period from 1992 to 2000 and faced considerable opposition, particularly from business groups, and Lloyd-Smith (2008) also cites industry pressure which resulted in reduced NPI reporting obligations, particularly in relation to pollutant transfers.

3.2 Mercury reporting

Whilst the above studies have considered reporting of multiple pollutants, few studies have specifically examined mercury accounting and reporting, despite the fact that the quality of mercury information has often been called into question. Mercury studies that have commented on mercury reporting - UNEP (2013a), AMAP/UNEP (2013), Hylander and Meili (2003), Mohapatra *et al.* (2007), Nelson (2007), Nelson *et al.* (2009), Strezov *et al.* (2010), Nelson *et al.* (2012) and Walcek *et al.* (2003) - suggest that most mercury information is deficient in terms of reliability, accuracy, comparability, consistency, verifiability, relevance and understandability. Globally, UNEP (2013a) and AMAP/UNEP (2013) observed that comparative analysis of global mercury emissions during the last 25 years is impossible due to changes in reporting, estimating approaches, additions of new sectors, differences in specification and classification of sectors. Moreover, changes in methods and units and lack of coordination among reports have produced inconsistent results (Walcek *et al*., 2003). Research on global emissions also uncovered significant under-reporting of mercury discharges from waste furnaces (Hylander and Meili, 2003). More specifically, reliable data collection is difficult from activities such as small scale gold mining, because it is unregulated and, in some cases, illegal (UNEP, 2013a). Deficiencies of mercury reporting have also been observed in relation to mercury trade: referring to United States Department of Commerce and International Enterprise Singapore, Ismawati *et al.* (2017) stated that though Singapore recorded 457 tonnes of mercury import from the USA in 2012 the USA recorded no export of mercury to Singapore.

In an Australian context, Nelson (2007) observed that the centralised reporting system of the NPI allows for a very limited scope of verifying mercury information. Furthermore, Nelson *et al*. (2009), Telmer and Veiga (2009) and Strezov *et al*. (2010) questioned the understandability

of mercury data, because of inconsistencies in estimating and reporting. Observing the inaccuracy of mercury data, Nelson *et al.* (2009) argued that higher quality data should be collected. It should be emphasised, however, that while these studies mentioned reporting and information quality these issues were not their primary focus. Hence, none of these studies followed any specific framework or performed a systematic review of mercury reporting quality.

The above review shows that whilst there have been prior reviews of the NPI, none have focused on mercury, whilst conversely prior studies which have discussed mercury information have not focused on the NPI. In addition, from a methodological perspective, whilst prior NPI studies have utilised surveys and case studies, none have utilised interviews, and none have engaged directly with NPI regulators. To address these gaps, this study explores the following research question: *Is the Australian National Pollutant Inventory's mercury accounting and reporting adequate to meet the reporting obligations under the Minamata Convention?* In order to answer this question we utilise the theoretical frame of accountability, operationalised via the qualitative characteristics of accounting information, which is explained in the following section.

4. Theoretical Framework

Accountability is a multidimensional construct (Sinclair, 1995), broadly defined as "the duty to provide an account (by no means necessarily a financial account) or reckoning of those actions for which one is held responsible" (Gray *et al.*, 1996, p. 38), and which has been applied to both corporate and government actors. Government accountability is more "political" accountability than "managerial" (Broadbent and Laughlin, 2003, p. 24), meaning that, the government is accountable to its people but the people do not have direct control over the government. The definition of public accountability includes not only financial but also "political, managerial, public, professional and personal" accountability (Sinclair, 1995, p. 220). In the context of multilateral environmental agreements, a national government's accountability reflects its "promises" to stakeholders in meeting the terms of the agreement, including other counties, citizens and the agreement's Secretariat (Brown and Moore, 2001, p. 570). Shiqiu (2014, p. 58) notes that a key challenge is to find the appropriate balance between community expectations of environmental responsibility, economic responsibility and legal compliance with the agreement.

A fundamental element of both corporate and public accountability is high quality reporting, but what constitutes 'quality' is somewhat subjective. The need for quality financial reports is well documented, and in relation to databases (as discussed in the previous section) high quality information is necessary to enable the "maxi-min" regulatory approach identified by Fung and O'Rourke (2000) and the other benefits cited by Stephan (2002). In terms of defining reporting quality, Miller and Bahnson (2003, p. 14) emphasise the honesty of reporting, stating that entities should "[t]ell the truth, the whole truth, and nothing but. Anything less is pointless and costly self-deception". Bailey *et al.* (2000, p. 203) emphasise the decision-usefulness of reporting, stating that accountability requires that reporting has value in terms of "facilitating action."

In this study, we evaluate the 'quality' of reporting with reference to the qualitative characteristics of accounting, derived from the conceptual frameworks of financial reporting, which have been extensively used in prior literature. Frameworks such as the *Characteristics*

of Accounting Information issued by the FASB in 1980 and the Australian Accounting Standards Board (AASB) *Conceptual Framework* issued in 2009 have long operationalised what 'quality' financial reporting means and encompass principles of both honesty and decision-usefulness. These qualitative characteristics have been explicitly adopted in the realm of social and environmental reporting, including in relation to pollutant databases, in a number of studies, summarised in Table 1. For example, O'Dwyer *et al.* (2005) and Comyns and Figge (2015) have both drawn upon qualitative characteristics in accounting to explore the quality of sustainability reporting. Most recently, Unerman *et al.* (2018) show how the qualitative characteristics underpin not only GRI reporting, but also sustainability reporting standards issued by the International Integrated Reporting Council, the Financial Stability Board Task Force on Climate-related Financial Disclosures, the Sustainability Accounting Standards Board and the Climate Disclosure Standards Board. In relation to pollutant inventories, as noted above, Burritt and Saka (2006) used qualitative characteristics of accounting to evaluate the relative merits of six pollutant databases. Government agencies and standard-setters have also explicitly reference the qualitative characteristics the GRI (2011) and OECD (2008) recommended using these characteristics for examining the quality of the social and environmental information of both public and corporate entities and the Canadian National Pollutant and Release Inventory (NPRI) uses seven qualitative characteristics of accounting information for ensuring the quality of reports (NPRI, 2017).

[Insert Table 1 about here]

The scientific community has also considered the characteristics of quality information and has ultimately reported similar characteristics to those used in accounting. One of the earliest investigations was Shannon and Weaver (1964), who identified three components of quality information: technical problems (quantification); semantic problems (meaning and truth) and influential problems (impact on behaviour). Their focus, however, was on technical problems and providing mathematical models for improving signal-to-noise ratios. Subsequent academic studies, summarised in Table 2, reveal a similar gamut of characteristics as the qualitative characteristics of accounting. Interestingly, however, Lee *et al.*, (2002) note that while practitioner views were broadly consistent with those of academics, a key difference was that practitioners considered characteristics to be more contextually dependent. Floridi and Illari (2014) provide an overview of the field and identify two further aspects for enhancing information quality: first, enabling users to form their own judgements about data quality by adding quality-related metadata to each observation; and second, creating a consistent metric for information quality that could be determined for each source.

[Insert Table 2 about here]

In light of these prior academic studies, as well as the *Characteristics of Accounting Information* issued by the FASB in 1980 and the Australian Accounting Standards Board (AASB) *Conceptual Framework* issued in 2009, we utilise the following set of qualitative characteristics to evaluate the quality of mercury reporting under the NPI: understandability, completeness, accuracy, verifiability, comparability and timeliness.[1] Whilst these characteristics are widely understood, for the sake of completeness we briefly define each term as follows. Understandability is the quality of information that allows reasonably informed users to perceive its significance, that is, to understand the content and significance of financial

[1] The IASB currently has a project to update its conceptual framework but this does not involve material revisions to the set of qualitative characteristics.

statements and reports. Completeness refers to reporting all the expected information that 'reasonably' fulfills the qualitative reporting requirements. According to FASB (1980, p. 32), completeness "implies that nothing material is left out of the information that may be necessary to ensure that it validly represents the underlying events and conditions". Adequate information disclosure is a significant condition of a "true and fair view" (Gill, 1983, p. 701). Accuracy means the information provided is correct; accuracy and reliability are almost synonymous as the reliability of information should be judged in terms of its accuracy. Miller and Bahnson (2007) denote reliability as the correspondence or agreement between a measure and the phenomena it purports to represent. Verifiability implies the justification of information by independent measures using the same measurement technique. Williams and Griffin (1969, p. 143) more broadly refer to verifiability as "the correctness of mathematics and logical arguments, the trustworthiness of reports, the authenticity of documents, the accuracy of historical and statistical accounts, the reliability and exactness of observations". Comparability enables information users to identify uniformities, that is, is the "quality or state of having certain characteristics in common, and comparison is normally a quantitative assessment of the common characteristic" FASB (1980, paragraph 115, p. 41). Timeliness refers to providing information promptly to decision makers. Wolk *et al.* (2013, p. 202) suggest that "to be relevant, information must be timely, which means that it must be available to decision makers before it loses its capacity to influence decisions".

5. Method

The primary data sources of the study are documentary analysis and semi-structured interviews. Documentary analysis consists of reviewing key background literature, including Hylander and Meili (2003), Mohapatra *et al.* (2007), Nelson *et al.* (2009), Strezov *et al.* (2010), and Walcek *et al.* (2003), and UNEP documents, including UNEP (2013a), UNEP (2013b), as well as information provided on the NPI website.

In addition to reviewing background literature, documentary analysis was performed of the submissions to the NPI review, conducted in 2018. The key areas of focus for the review were "identifying whether the right substances were being reported, the most valuable information was being collected and whether the collection was cost effective" (NEPC, 2018, p. 8). 60 direct submissions were received, 54 of which were publicly available on the NPI website. 314 submissions were made via a campaign form on the Environmental Justice Australia website, which were not made publicly available. The length of these submissions ranged from 1 page to 25 pages, summarised in Table 3. The submissions were reviewed, with an emphasis on the more detailed submissions, and points made were categorised using the qualitative characteristics described in the previous section.

[Insert Table 3 about here]

In addition to the documentary analysis, ten semi-structured interviews with 13 interviewees were conducted, summarised in Table 4. Semi-structured interviews were selected as this approach allows the capture of both richer and more focused data than fully structured or unstructured interviews (Fontana and Frey, 2000). These interviews were conducted in two batches: the first 8 interviews were conducted in 2015-16 and two follow-up interviews were conducted in 2020 to gain additional insights from the perspective of corporate reporters. The duration of these in-depth interviews was from 40 to 93 minutes with an average of 69 minutes.

Two interviews were undertaken in person, six via telephone and two via videoconference and the others via telephone.

[Insert Table 4 about here]

We interviewed people from different backgrounds and locations, including academic mercury researchers, UNEP mercury experts, regulators such as NPI regulators and administrators from various regions of Australia and Australian Government NPI representatives. A corporate perspective was provided by interviews with a corporate reporter and two consultants who prepare NPI reports on behalf of multiple corporate clients. Interviewers A and B conducted all of these interviews, with the exception of interviews 9 and 10, which were conducted by interviewer B alone. All the interviews were recorded with the prior permission of the interviewees except for interview 2, where the interviewers took handwritten notes. Interviewees were also given the option to talk 'off the record' if and when they chose, but none did so. These interviews explored different aspects of current Australian mercury reporting, particularly an evaluation of the mercury reporting processes and mercury information.

Although we conducted a relatively small number of interviews, our interviewees covered the major parties related to mercury emissions including academic researchers, UNEP mercury experts, state and territories regulators, Australian Government regulators, and a corporate mercury reporter. We also reached the "interview to saturation" (Trotter, 2012, p. 399) as additional interviewees provided almost the same opinions as those of the previous interviewees. Moreover, qualitative research is usually conducted based on a small number of samples (Gentles *et al.*, 2015; Ritchie *et al.*, 2003) because additional interviews provide very little new information and qualitative research works collect data that are "rich in details" (Ritchie *et al.*, 2003, p. 83). Our sample was within the range recommended by Marshall *et al.* (2013) of between six and 50 interviews.

The interview responses were transcribed, then analysed based on the methods explained by Ryan and Bernard (2000), O'Dwyer (2004) and O'Dwyer *et al.* (2011). Initial codes were ascertained from the discussions of the background and theoretical frames. Initial codes were used in the first coding pass, and new codes were included when new dimensions were identified. Interview notes were also used for determining additional dimensions. All transcripts and notes were evaluated for the identified codes in the second pass, and a draft was prepared as a tool for arranging interview themes. As noted above, a summary of key themes was also provided to interviewees for clarification and comment.

6. Findings

Overall, all regulators (7 out of 7) believed that NPI data would be sufficient to meet Australian reporting obligations, especially in comparison with the non-existent or unsophisticated reporting regimes of many developing countries. The major strengths of the NPI include an appropriate reporting threshold level, public data availability, administration by state and territory governments with good relationships with industry, and a long history of data.

Whilst this assessment was encouraging, the study also identified a number of weaknesses. A summary of the reporting quality elements referred to in inquiry submissions is provided in

Table 5 (as these elements were part of the interview questions, they were all discussed in each interview).

[Insert Table 5 about here]

The primary issue was the lack of data and reporting on diffuse source emissions, but other concerns included understandability, consistency, timeliness and relevance. A common theme was the reduction in funding for the NPI at both Australian Government and state and territory levels that has resulted in diminished data quality across a range of dimensions. Interestingly, in addition to government agencies and NGOs, industry also voiced concerns about the extent to which the NPI was fulfilling its mission, such as in the following submissions:

> *CME support the public's right to know about substances which are potentially harmful to the environment and human health. This right to know however can only be fulfilled if the public has access to data that is accurate, current, complete and understandable. CME does not believe the NPI currently meets these criteria* (Submission by Chamber of Minerals and Energy of Western Australia, p. 7)

> *[T]he accuracy and completeness of the inventory need to be improved for it to be valuable in policy work, benchmarking and tracking performance.* (Submission by NSW Minerals Council, p. 4)

In addition to the potential negative implications for the quality of national mercury reporting, these issues are concerning given that many organisations – especially NGOs – commented on the importance of the NPI for public health, such as the following:

> *It is Australia's most comprehensive annual report on toxic pollution to air, water and land, providing a level of community right-to-know that is otherwise unavailable.* (Submission by the Public Health Association of Australia, p. 4)

> *Environmental Justice Australia and the communities we work with use the NPI extensively to identify major sources of air pollution, to understand trends and to advocate for pollution control.* (Submission by Environmental Justice Australia, p. 3)

The findings are presented first based on the qualitative characteristics of the accounting information: understandability, accuracy, verifiability, comparability, timeliness, and completeness. These characteristics were explicitly explored in the interviews, and as Table 5 indicates, were also pervasive in the inquiry submissions. We then discuss resourcing as this was a common theme brought up by both interviewees and submissions, and potentially impacts all dimensions of reporting quality.

6.1 Understandability

The data revealed strong concerns regarding the understandability, usage, and usefulness of mercury information. While interviewees (9 out of 13) generally agreed that the information was presented in an understandable manner (at least, to an experienced user), the primary concern was that interpretation is difficult, which may lead to erroneous conclusions being drawn. The following statement captures the views of many submissions and interviewees:

> *The industry has concerns there is public confusion and misinterpretation of NPI data. Making data available does not necessarily translate into understanding.* (Submission by Minerals Council of Australia, p. 4)

There are a number of challenges to 'translate into understanding' NPI data. The first is that the data is provided in a raw form, in that only the amount of emissions is provided. The second is that whilst the NPI provides information regarding the toxicity of mercury (and the other substances) it does not give information about what a safe exposure threshold might be for public health. The following quotes are representative of this point:

> *We produce, or we publish the emission estimates of the 93 substances that the NPI covers. Facility X says they emit 40 kilograms of this and 20 kilograms of that, and another industry says we emit 10,000 kilograms of this and five kilograms of this. However, what's missing is the context in data . . . there's no broader context to the information. It is literally just a data summary. So it is easy to understand from a data perspective but from a context perspective, there's nothing.* (Interviewee 5, Regulator)

> *[A]ctually understanding what the implications of those emissions are, I don't think it goes very far in that regard.* (Interviewee 10, Regulator)

A further issue, however, is that the community impact of a given emissions profile is not evident from NPI data. Factors such as weather, local topography and emission stack heights were raised by both corporate and regulatory interviewees as having a significant influence on emission impacts, but this is not currently reported in the NPI:

> *Also there's a need to be a little bit more sophisticated in the way the information is presented – or there's an opportunity to do that. If you – things like stack heights, for example. So, if you have a lot of emissions coming out of – or potentially hazardous emissions coming out of a chimney stack, if it is a low stack – therefore they are closer to the ground – the emissions occur closer to the ground, and the community is more likely to be exposed to those emissions. That is a worst case scenario. If it is a very tall stack and the emissions are released at a much higher level, then there will be some overall atmospheric impact. But, actually, the impact on the local community is considerably reduced because the emissions are occurring at a higher level in the atmosphere.* (Interviewee 10, Regulator)

Some submissions and interviewees suggested that data presentation of the NPI can be made more sophisticated for improving the usefulness and understandability of data to the community, non-government organisations and health organisations that want to understand the potential exposure to emissions. For example, a recommendation by the Australian Energy Council was to:

> *Update the NPI website to include context between emissions and exposure to assist the public in understanding their risks.* (Submission by Australian Energy Council, p. 10).

In a similar vein, the Public Health Association of Australia stated:

> *The [NPI] data and reporting must be easy to interpret to ensure that users are able to easily identify where pollutants have exceeded thresholds above which they are damaging to health and the environment.* (Submission by the Public Health Association of Australia, p. 11)

The inclusion of data on stack heights is one example, but a more ambitious proposed improvement is correlating the emissions data with atmospheric and weather data. Moreover, these improvements to data presentation could be made without any additional reporting burden on industry. Whilst there were dissenting views – for example the submission by the Australian Pavers Association stated that providing such contextual information was not the role of the NPI, given the difficulty of the task – the majority of submissions and interviewees who commented on this facet of reporting believed that the provision of additional contextual information was a vital part of providing useful information.

This finding echoed much previous research. The students surveyed by Howes (2001) indicated that the NPI compared poorly to the US TRI in terms of the provision of contextual information, which diminished the utility of NPI data. In the context of emissions by power stations Tang and Mudd (2015) suggested that understanding was compromised by the lack of both calculation details and production volumes.

6.2 Completeness

A strong concern across the data was concerns regarding the completeness of the information reported by the NPI, which was primarily due to the lack of diffuse source emission reporting by government agencies. The point was made by numerous submissions that this omission compromised the understandability of the dataset, illustrated by the following:

> *Without updated annual emissions from diffuse sources, the aggregated emission inventory does not represent a complete picture of total emissions. This is a significant limitation when trying to understand and interpret the dataset.* (Submission by NSW Minerals Council, p. 1).

An especially interesting element of many submissions was the complaint that onerous reporting requirements imposed on industry were not matched by a corresponding effort by government agencies to conduct appropriate levels of reporting. This is well illustrated by the case of Western Australia in the following submission:

> *Western Australia's (WA) diffuse source data has not been updated since the launch of NPI (1998-1999). At this time, the population of Perth was 1.87 million compared to 2.58 million in 2017-18, hence it can hardly be expected for the total urban diffuse sources data to be accurate, current or complete and it is therefore of limited public health use. This is quite different to the currency of industry emissions data with industry required to update data annually and this requirement enforced by government.* (Submission by Chamber of Minerals and Energy of Western Australia, pp. 7-8)

It was acknowledged by regulators that the diffuse information had not been captured or updated in many jurisdictions. Two explanations were offered, both of which were related to limited resourcing. The first was that at the State and Territory level, interviewees suggested that when diffuse source studies were conducted, this information was passed on to the Federal level but languished for many months or longer before being posted on the NPI website. At the Federal level, these delays were explained by a lack of resources. The second reason was that limited NPI budgets at the State and Territory level required some activities to be reduced or cut, and the diffuse source studies were often one of the first things to be abandoned, partly because they were not being posted on the website anyway.

These concerns regarding diffuse emissions corresponded with the findings of Zuo and Wheeler (2019), who reported greater levels of dissatisfaction regarding diffuse emissions than point source emissions (42% vs 28%). The findings of Cooper *et al.* (2017) are also particularly interesting, given that this study identified significant deficiencies in both the method and timeliness of diffuse emissions in relation to lead. Given that half of Australian mercury emissions are from diffuse sources (NPI, 2008 cited in Dutt *et al.*, 2009), the deficiencies noted in relation to diffuse source data are cause for concern.

There were also some concerns regarding the completeness of point source emissions, though these were nowhere near the same level as the concerns regarding diffuse emissions. The majority of interviewees (11 out of 13) believed that point source data was reasonably complete, but concerns were raised that some organisations were not reporting because handbooks had not been produced:

> *So, it's quite possible that the data completeness thing would be affected because we don't supply emission factors. We don't have it – our view here in [our state], which isn't the same view which is held nationally, is that if there's no emission estimation technique available, then the substance doesn't need to be reported.* (Interviewee 7, Regulator)

Both regulators and corporate interviewees also suggested that completeness could be compromised because organisations did not know they were required to report, or that they simply did not fulfill their reporting obligation. Corporate interviewees suggested that in some jurisdictions the EPA played an important role in alerting organisations that they had to report via the NPI when the EPA granted them pollutant licences. However, this opportunity was limited because in some States and Territories there was limited interaction between EPA and NPI teams, and even in those regions with strong links the data required for pollutant licences was different from that required by the NPI. For example, a pollutant licence might be for a certain ratio of pollutant to water discharges (i.e. pollutant parts per litre) whereas NPI reporting was based on the aggregate discharge of pollutants.

Finally, both submissions and interviewees raised concerns in terms of the completeness of the inventory of pollutants disclosed via the NPI. Whilst recommendations regarding specific substances that should be added to the listing were not made, it was noted that the NPI encompasses a much narrower range of pollutants compared to international counterparts, which corresponded with prior observations by Burritt and Saka (2006) and Lloyd-Smith (2008).

6.3 Accuracy

Most commentary in relation to the accuracy of NPI data related to emission manuals. As noted in Section 2, the NPI allows either the direct measurement of emissions or the use of estimation manuals. Some interviewees (4 out of 13) suggested that the flexibility of different types of reporting and the inability to capture voluntary transfers result in a lack of reliability in the NPI generated mercury data, illustrated by the following quote:

> *[T]here may not be that absolute knowledge of how reliable that data might be or how specific it is, because there might be a bit of a variation then, depending on what type of methodology has been used to calculate those emissions.* (Interviewee 8, Regulator)

These manuals are prepared on an industry basis (for point sources) or category (for diffuse sources) and typically provide a formula for estimating one or more pollutant emissions based on levels of inputs or outputs. Both the enabling of multiple accounting methods and the quality of the manuals themselves were flagged as undermining the accuracy of reported data. Both submissions and interviewees stated that many manuals had not been updated for some time, and the formulas were often derived from studies conducted in other countries, which may not be applicable to Australia (due to, for example, different soil or other climatic conditions). The following submission provides a useful summary of these concerns:

> *In the case of mining fugitive dust emission factors, they are largely based on decades-old research from the United States. The conditions under which these emission factors were developed are quite different from Australian conditions and contemporary mining practices.* (Submission by NSW Minerals Council, p. 3).

Again, these findings resonate with prior studies: the accuracy of estimation manuals were critised by Cooper *et al.* (2017) and Kolominskas and Sullivan (2004), and 68% of respondents to the survey by Zuo and Wheeler (2019) called for more robust estimation methods. Of particular note was the detailed study of Cooper *et al.* (2017) into the diffuse manual for the calculation of lead emissions from vehicles travelling over unsealed roads. A comparison of best practices with the current NPI manual revealed that the manual was badly out of date, in that it ignored the input of average vehicle speed in the emissions calculation, which might mean emissions were over/under reported by a factor of 3 and the estimates were also based on calculations before the phase out of unleaded petrol. Similar deficiencies in mercury-related estimation manuals could have similarly detrimental impacts on mercury reporting.

An interesting point made by corporate interviewees was that NPI calculations are complex and take time to master. This means that accurate reporting is unlikley in the first year of reporting, and it may take up to three years for accurate information to emerge. Interestingly, there was little sense by either regulators or corporate reporters that errors would be deliberate, but rather that NPI reporting was often not seen as an operational priority by organisations and a lack of focus, perhaps coupled with a lack of experience, were the most likely source of errors.

6.4 Verifiability

There are different views amongst the interviewees on the adequacy of verification of mercury information. Prior literature and some interview responses suggest that the numbers are not appropriately audited. NPI staff from the state and territory level strongly emphasised that they do verify each report received via a ‘desk audit’. This verification includes comparing the emissions of the current year with those of the previous year, comparing emissions with information about fuel consumption and volume of production and identifying facilities reporting with significant variations in emission levels. Particular scrutiny is given to larger facilities, newly reporting facilities and consistently poor reporters. Additional verification steps include asking for clarification and evaluating the feedback received as well as site visits and consulting with facilities to fix reporting problems and improve reporting capacities.

One interviewee outlined the secondary processes that are applied for verification as below:

> *If at the end of that we are still not satisfied that the data they've given us is representative or makes sense in the context of their historic operations then we will query them, and we will send feedback, very specific feedback saying we have noticed*

> *this … Sometimes there're more systemic areas that we have to go and do a bit of work to help them fix … we visit, and we inspect. We review their calculations in detail; you know fine comb, we get their spreadsheets.* (Interviewee 5, Regulator)

Whilst regulators (7 out of 7) were satisfied that current verification processes are adequate, regulators agreed that the recent reduction in resourcing threatens the ongoing verification of mercury data (particularly for remote sites) as NPI personnel are being reduced in many regions. Inquiry submissions also reflected this sentiment:

> *The current resourcing is not adequate to perform comprehensive NPI data verification and error checking and follow up on non-reporting.* (Submission by Queensland Department of Environment and Science, p. 15)

From the perspective of non-regulator interviewees (6 out of 6), there was little direct experience in being subjected to an NPI audit. Whilst they were aware that such audits were possible, none had personally experienced an audit and only one had heard any accounts of such an audit being undertaken. In the industry submissions there was little commentary regarding the current auditing regime, save for the Cement Industry Foundation, which commented that:

> *All CIF members have been audited numerous times by the various jurisdictions and remain subject to further, random audits* (Submission by Cement Industry Foundation, p. 7)

Objective evidence in relation to the extent of the verification of NPI data is provided by the annual report of the National Environment Protection Council, and the latest available data, for the 2016-17 reporting year, is summarised in Table 6. This shows that the level of 'desktop audits' varies considerably between regions and accounts for 73.8% overall. On-site audits, however, are exceptionally rare, comprising only 19 of 4,145 reports lodged (0.5%). Regulatory actions taken, are rarer still, comprising zero. A review of the previous two reports of the NEPC revealed similar ratios for 2015-16 (and 2014-15); desktop audits: 73% (78%); on-site audits: 0.6% (0.7%); regulatory actions taken: nil (nil).

[Insert Table 5 about here]

The evidence suggests that there is considerable scope for more rigorous auditing of NPI data. The fact that very few site visits have occurred, and not a single regulatory action taken over the past three years suggests that errors may be going undetected and contraventions unpunished. Further, the wide discrepancy between the regions in relation to the prevalence of desktop audits – from 100% in NSW to 22% in Victoria, despite similar numbers of lodgements – suggests that verification efforts are not being consistently applied. It is also odd that NSW have disclosed neither on-site audits nor regulatory actions for 2016-17 lodgements (or for the prior two years).

6.5 Comparability

The main concern relating to the comparability of NPI data was the ability of reporters to choose different calculation methods, coupled with the fact that the calculation methods adopted are not disclosed. As noted above, industry handbooks are provided to help emissions calculation, and the industry handbooks typically contain a variety of measurement options,

including direct measurement, use of emission factors (i.e. formulas based on production) and mass balances (comparing the mass of a substance at the beginning and end of the process and recording the difference as an emission). Whilst these choices may reduce the reporting burden for organisations, in that they can choose the method they deem most appropriate, the provision for such choices reduces comparability. This concern was identified both within submissions, and by 10 out of 13 interviewees:

> *I guess you've always got the aspect that you can't always compare one facility to another……. So we do try to do validation of different - like just say for example we tried to do the mining sector together, although it depends as well. Sometimes they're quite different as well between what they do.* (Interviewee 8, Regulator)

> *As the guidance to reporting is open to interpretation, there is no ability to compare like with like and when data is presented publicly, it can be misleading. NPI should be more specific on reporting requirements and particular industries should report on an NPI defined group of emission sources in a specified, agreed manner* (Submission by Austalian Institute of Petroleum, pp. 5-10).

Apart from issues with the comparability of underlying data, the ability of users to compare performance is also hampered by the NPI interface, and in particular the difficulty in obtaining time-series information. This point was made by many submissions, but most vividly by the following:

> *It is not possible, for instance, to compare the toxic emissions from a power station year by year. Instead, it is necessary to download the data for each year, then import multiple csv files into Excel to make this comparison . . . A programmer with modest skill levels could create a more user-friendly interface in no time. When community members can easily compare polluters' reports year by year, and quickly access the full details of emission control measures implemented, polluters will begin to be held to account.* (Submission by Australian Conservation Foundation, p. 3).

The concerns expressed regarding comparability suggest that the issues reported by prior studies remain unresolved. Recall that Cooper *et al.* (2017) found that the methods adopted by Mount Isa Mines changed 7 times over 14 years, Tang and Mudd (2015) called for increased details regarding calculation methods and production levels and 63% of respondents to the survey by Zuo and Wheeler (2019) called for nationally consistent measurement methods.

Compromised comparability is particularly problematic given that of all the qualitative characteristics, comparability is arguably the most important in order to realise the potential of a pollutant database such as the NPI, and hence in the context of the present study, to act as a catalyst for reducing mercury emissions. The mechanisms for change identified by Fung and O'Rourke (2000) and Stephan (2002), and the potential of databases for enhanced accountability articulated by Leong and Hazelton (2019), fundamentally relies on regulators and/or citizens being able to focus on the worst performers, which is impossible without comparative information. The issues noted above call into question the extent to which the NPI can provide comparative mercury information.

6.6 Timeliness

As noted above, the main concern in relation to timeliness in submissions and by interviewees was the delays in reporting diffuse source emissions (13 out of 13). As noted in the discussion

on completeness, for diffuse sources, state and territory governments usually procure measurement studies by external scientists or government agencies. States and territories submit the data to the Australian Government for entry into the NPI as the Australian Government ensures that the data is correctly formatted. However, interviewees reported that there is a lag of some *years* in data being entered into the system. Consequently, faced with funding cuts, states and territories are reducing efforts to collect diffuse source data as there seems little point in collecting data that will not be processed on a timely basis. Submissions called for greater coordination to address this issue, such as the following:

> *Improved interactions between governments may address the provision of timely and accurate information on diffuse emissions, which may, in turn, provide a complete emissions profile. This would benefit the public, industry and the various government departments involved in decision-making on emissions, pollution and air quality issues* (Submission by Minerals Council of Australia, p. 9)

Regulators stated that while IT systems were being upgraded, which should reduce this bottleneck, funding constraints limit their ability to do what is really desired, namely a comprehensive system update:

> *[I]t's difficult in a resource constrained environment for the department to allocate resources to – enhancing an IT system that is a fairly old, bespoke IT system. When, really, what we would rather do is rebuild something or build a new system, but we don't have the capital resources to do that. So it's a bit of a piecemeal process, and that takes a little bit of time to get the approvals to undertake those projects.* (Interviewee 10, Regulator)

The delays noted above in generating diffuse source data corresponded with the finding by Cooper *et al.* (2017) that the most recent study of diffuse lead emissions in relation to the area of interest – emissions from unpaved roads - was over a decade old. Interestingly, Cooper *et al.* (2017) reported that identifying the lag in reporting was not easily facilitated by the NPI interface, in that diffuse emissions may be reported by the calculation date, as opposed to the data collection date. In other words, a given formula may be applied in 2020, which might give the impression of up-to-date information, but the underlying data may have been collected many years previously.

In relation to point source data, this was one of the few areas where the NPI was reported to be functioning adequately. Whilst it was acknowledged that there could be delays in providing this information, there were few calls for substantive changes to the existing processes or timeframes. Given that the international comparison provided by Burritt and Saka (2006) showed that the NPI provides point-source data to the public quickly by international standards, and therefore it is not surprising that this was not identified as a major concern.

6.7 Resourcing

As is evident from the preceding discussion, a recurring theme in submissions and by interviewees (13 out of 13) is resource constraints, which are significantly hampering the capacity of the NPI in discharging its accountabilities. This point was made by governments, NGOs and industry submissions illustrated by the following:

> *More funding should be provided for the NPI. The current resourcing is not adequate to perform comprehensive NPI data verification and error checking and follow up on non-reporting.* (Submission by Queensland Department of Environment and Science, p. 15)
>
> *[T]he NPI has not realised its potential, primarily because of continuing reductions in Commonwealth funding and resources which limited NPI operations to basic maintenance* (Submission by Public Health Association of Australia, p. 4)
>
> *Additional funds could be directed to the development of: centralised reporting, real-time online data validation tools, up-to-date and comprehensive data on diffuse emissions sources* (Submission by Cement Industry Federation, pp. 10-11).

Similarly, almost all the interviewees expressed their concerns about the reduction of resources allocated to the NPI by the Australian Government, and staff cuts at the Australian Government and state and territory levels. Interviewees stated that there was initially significant support for the NPI, with one describing it as 'very well resourced' (Interviewee 8, Regulator). Over time, however, resourcing has diminished and all interviewees agreed that that funding cuts had reduced the quality of NPI data across the board, particularly in terms of diffuse emission data collection and reduced verification activities.

Going forward, however, submissions from industry were (unsurprisingly) opposed to industry bearing the cost of increased NPI funding, arguing that costs were already borne by industry in terms of reporting obligations and pollutant licencing. This position was perhaps made most eloquently in the following submission:

> *[I]f the government see value in the NPI for the Australian public, it will continue to fund its component of NPI service delivery . . . CME reiterate industry already incurs a significant annual cost for delivery of this public good through external consultants, in-house personnel and direct monitoring costs, and it should not be asked to provide further funds direct to government for cost recovery of the NPI. Further, WA NPI reporting facilities are already charged both "per facility" and "per emission" fees through the State's licensing processes under Part V of the Environmental Protection Act 1986. A cost recovery model would add further financial burden to facilities and would essentially be charging industries twice for the same pollutant* (Submission by Chamber of Minerals and Energy of Western Australia, pp. 10-11).

In sum, there seems to be widespread agreement that current funding models of the NPI are inadequate, but the mechanism by which such funding should be increased remains highly contentious.

Interestingly, NPI resourcing was not a point foregrounded in the prior literature. The history of the NPI provided by Lloyd-Smith (2008) does not devote specific attention to this issue, and whilst funding constraints are mentioned by Howes (2001), no details are provided either of the funding arrangements nor what particular compromises funding constraints entailed. Similarly, Burritt and Saka (2006) make no comment in relation to the funding levels or arrangements of the six pollutant databases they compare, and resourcing was not an item included in the survey conducted by Zuo and Wheeler (2019). In relation to the case studies conducted by Kolominskas and Sullivan (2004), Tang and Mudd (2015) and Cooper *et al.* (2017) there is no discussion of NPI resourcing.

7. Conclusions

This paper evaluates whether the NPI is of sufficient quality to enable Australia to meet its mercury reporting obligations under the Minamata Convention. More broadly, the NPI is of interest as it is an example of mandatory public reporting via pollution database, and as such may at least partly address the problems of organisational sustainability reporting such as reporting boundaries and materiality. Prior literature on mercury highlights a number of quality limitations in mercury reporting processes, both overseas and in Australia, and prior literature on the NPI has criticised various aspects of the reporting regime. The quality of mercury reporting has not been the focus of prior studies either within social and environmental accounting or in the broader literature, and prior studies on the NPI have not previously engaged directly with regulators.

This paper has used the qualitative characteristics of accounting as a theoretical framework to analyse data from ten interviews with thirteen interviewees as well as 54 submissions to the 2018 inquiry to the National Pollutant Inventory. While interviewees considered that Australian mercury accounting is sufficient to meet the expected Minamata reporting requirements, this position is largely justified on the basis that many signatories are developing countries with little mercury reporting, and Australia's information is therefore sophisticated by comparison.

Both interview and submission data reveal a number of limitations in measuring and reporting mercury under the NPI, particularly in relation to comparability, accuracy, timeliness and completeness, which have important implications for mercury reporting. Comparability is arguably the most important characteristic of an effective pollutant database (Fung and O'Rourke, 2000; Leong and Hazelton, 2019; Stephan, 2002), but NPI data is difficult to compare both between reporters or between years as NPI rules allow organisations to follow different methods of measurement and even different methods in different years, and there is no disclosure of detailed calculations nor contextural information such as production volumes. This finding corresponds with previous work (Cooper *et al.*, 2017; Tang and Mudd, 2015; Zuo and Wheeler, 2019). Accuracy is compromised primarily due to estimation manuals that are inaccurate and/or out of date, as well as inconsistent approaches to data verification and monitoring, which implies that the latest mercury science is unlikely to have been translated into NPI reporting. This finding is also consistent with prior work (Cooper *et al.*, 2017; Kolominskas and Sullivan, 2004; Zuo and Wheeler, 2019). Whilst timeliness of point source data was generally considered adequate, a consistent theme was the poor timeliness and completeness of diffuse source data. The lack of completeness of the NPI's scope in terms of the number of pollutants covered was also noted as a weakness of the regime. Again, these findings are consistent with prior work (Burritt and Saka, 2006; Cooper *et al.*, 2017; Howes, 2010). Collectively, these findings suggest that whilst it may well be true that Australian mercury reporting is superior to other signatories of the Minamata Convention, there is considerable scope for improvement. In addition to deficiencies in mercury reporting, these findings also raise concerns regarding the quality of reporting of the other 92 substances encompassed by the NPI regime.

A finding that may be somewhat surprising to SEA researchers is that the main weaknesses of NPI reporting relate to government, as opposed to industry, deficiencies. Neither regulators nor other stakeholders reported concerns that the rules were being broken by corporations, rather, they suggested that the rules themselves were deficient. Further, it was lack of government action – both in terms of updating estimation manuals used by industry and by limited measurement of diffuse emissions – that was cited as the key problem by all stakehoders,

including regulators themselves. This suggests that while calls for mandatory social and environmental reporting may be valid (Adams, 2004; Adams and Zutshi, 2004; Gray and Milne, 2004), the success of such regimes relies as much the governing as it does on the governed. This finding provides further insight into the conditions required for databases to create the organisational change described by database advocates (Fung and O'Rourke, 2000; Leong and Hazelton, 2019; Stephan, 2002). In particular, whist the NPI might successfully address the issue of reporting boundaries (Gray, 2010; Gray and Milne, 2004) it does not address the issue of materiality (Canning *et al.*, 2018), in that material information is not being provided to stakeholders.

This finding might be further understood using the accountability frame proposed by O'Dwyer and Boomsma (2015), which suggests that a combination of more rigorous rules and a greater sense of ethical obligation will be required to improve reporting. The NPI reporting framework for mercury is a complex network which includes elements of 'imposed' accountability (via reporting rules) and 'felt' accountability (via ethical commitment). For point sources, the relationship between corporations and State and Territories is primarily one of imposed accountability, as reporting of point source mercury emissions is mandatory and controlled by the state and territory governments, but the existence of numerous loopholes means that it relies on felt accountability for meaningful reporting. For diffuse sources, state and territory governments sponsor studies that are often done by external scientists or other government agencies. Whilst these are reported to the Australian Government, there are limited reporting requirements and hence most accurately defined as felt accountability. The Australian Government is responsible for disseminating mercury information to the general public, but as the public has limited capacity to compel the government to release mercury information within a stipulated time or impose sanctions when promises are broken the relationship is essentially one of felt accountability. In relation to mercury reporting under the Minamata Convention, while this has elements of felt accountability (in that there was no requirement for Australia to become part of the Convention and few sanctions can be imposed for non-compliance with international agreements) the relationship between Australia and the Convention Secretariat also has elements of imposed accountability via reporting obligations. Given the co-existence of imposed and felt accountability at so many levels, improvement of both aspects is required: efforts to tighten the rules of the NPI must also be accompanied by efforts to win the 'hearts and minds' of all stakeholders.

A finding that is also novel to prior work relates to the main cause attributed to these deficiencies – namely, lack of resources. Prior discussions of the limitations of the NPI have primarily focused on the reluctance of regulators to improve the NPI due to industry influence (Howes, 2010), and while this is undoubtably valid, many industry submissions to the NPI review called for both greater rigour in the system and greater funding (though not from industry!). Regulators consistently cited lack of funding as the primary reason for the current weaknesses in the system. The need for adequate resources – comprising both financial resources and capability - has been cited as a critical element for national compliance with multilateral agreements (e.g. Zhao and Ortolano, 2003), and for accounting practices and bodies (e. g. Bracci *et al.*, 2015, p. 897). Resourcing, however, has not been a factor highlighted in prior research regarding the NPI, nor in the accountability literature.

Our findings lead to several policy recommendations for the reporting of mercury and other pollutants, especially increased resourcing, enhanced reporting of diffuse emissions and updating NPI handbooks. Resourcing of central (Federal) and regional (State and Territory) NPI operations is essential as improvement of current practices is unlikely without additional investment. Assuming further resources become available, addressing the frequency and

timeliness of capturing and reporting diffuse emissions is arguably the single biggest priority for data improvement. A close second is updating and improving the NPI handbooks, many of which do not appear to reflect local conditions nor the latest science. Whilst these are priorities, numerous other areas could also be improved, including coverage of additional pollutants; tightening reporting rules and providing additional disclosures to enhance comparability; and consistency in approaches to data verification and monitoring.

This study has several limitations which might be addressed by future research. First, whilst many areas of the NPI were identified as problematic in relation to the quality of Australian mercury reporting, specific errors were not identified. Future work could follow the approach of Cooper *et al.* (2017) and compare the most important estimation manuals for mercury with the latest mercury research, as well as examine the timeliness and coverage of diffuse source studies. Future work could also explore the implications of the differing levels of toxicity of different mercury compounds, as well as the extent to which reported information can be used to predict future emissions, neither of which were considered in the current paper. Other aspects of governance of the Minamata Convention and reporting sources could also be considered. More broadly, further research on the potential for databases to impose accountability and drive organisational change might use the O'Dwyer and Boomsma (2015) framework to further explore the drivers of felt accountability, which could encompass the institutional logics at play by both corporate and government actors in a database setting. Future work could also examine the extent to which lessons from accounting regulation might apply in the context of pollution databases, and vice versa. Future studies might seek to address the gap in research in relation to the funding of pollutant databases, both empirically (such as exploring relative levels of funding between countries, and the relationship between fundings and capability) and theoretically (such as by explicitly incorporation notions of resources into accountability frameworks). Finally, future studies might seek to integrate accounting notions of information quality with the emerging field of the philosophy of information, with particular reference to the novel aspects noted by Lee *et al.* (2002) and Floridi and Illari (2014): contextually-driven characteristics, metadata and quantitative assessment of information quality.

References

Adams, C. (2004), "The Ethical, Social and Environmental Reporting-Performance Portrayal Gap", *Accounting, Auditing & Accountability Journal*, Vol. 17 No. 5, pp. 731-757.

Adams, C. A. and Zutshi, A. (2004), "Corporate social responsibility: why business should act responsibly and be accountable", *Australian Accounting Review*, Vol. 14 No. 34, pp. 31-39.

AMAP/UNEP. (2008), "Technical background report to the global atmospheric mercury assessment", Arctic Monitoring and Assessment Programme, Oslo, Norway.

AMAP/UNEP. (2013), "Technical Background Report for the Global Mercury Assessment 2013", UNEP Chemicals Branch (Ed.). Arctic Monitoring and Assessment Programme, Oslo, Norway.

AMAP/UNEP. (2019), "Technical Background Report to the Global Mercury Assessment 2018", Arctic Monitoring and Assessment Programme, Oslo, Norway.

Ane, P. (2012), "An Assessment of the Quality of Environmental Information Disclosure of Corporation in China", *Systems Engineering Procedia*, Vol. 5 No. 3, pp. 420-426.

Antheaume, N. (2007), "Full cost accounting: Adam Smith meets Rachel Carson?", in Unerman, J., Bebbington, J. and O'Dwyer, B. (Eds.), *Sustainability Accounting and Accountability*. Routledge, Oxon, pp. 211-225.

Atlas, M. (2007), "TRI to Communicate: Public Knowledge of the Federal Toxics Release Inventory", *Social Science Quarterly*, Vol. 88 No. 2, pp. 555-572.

ATSDR. (2001), "2001 CERCLA Priority List of Hazardous Substances", available at: https://www.atsdr.cdc.gov/spl/previous/01list.html (accessed 10 May 2014).

Axelrad, D. A., Bellinger, D. C., Ryan, L. M. and Woodruff, T. J. (2007), "Dose-Response Relationship of Prenatal Mercury Exposure and IQ: An Integrative Analysis of Epidemiologic Data", *Environmental Health Perspectives*, Vol. 115 No. 4, pp. 609-615.

Bailey, D., Harte, G. and Sugden, R. (2000), "Corporate disclosure and the deregulation of international investment", *Accounting, Auditing & Accountability Journal*, Vol. 13 No. 2, pp. 197-218.

Ballou, D. P. and Pazer, H. L. (1985), "Modeling data and process quality in multi-input, multi-output information systems", *Management Science*, Vol. 31 No. 2, pp. 150–162.

Bebbington, J. and Larrinaga, C. (2014), "Accounting and sustainable development: An exploration", *Accounting, Organizations and Society*, Vol. 39 No. 6, pp. 395-413.

Bebbington, J. and Unerman, J. (2018), "Achieving the United Nations Sustainable Development Goals", *Accounting, Auditing & Accountability Journal*, Vol. 31 No. 2-24.

Bjornberg, K. A., Vahter, M., Pertersson-Grawe, K., Glynn, A., Cnattingius, S., Darnerud, P. O., Atuma, S., Aune, M., Becker, W. and Berglund, M. (2003), "Methyl Mercury and Inorganic Mercury in Swedish Pregnant Women and in Cord Blood: Influence of Fish Consumption", *Environmental Health Perspectives*, Vol. 111 No. 4, pp. 637-641.

Bracci, E., Humphrey, C., Moll, J. and Steccolini, I. (2015), "Public sector accounting, accountability and austerity: more than balancing the books?", *Accounting, Auditing & Accountability Journal*, Vol. 28 No. 6, pp. 878-908.

Broadbent, J. and Laughlin, R. (2003), "Control and Legitimation in Government Accountability Processes: The Private Finance Initiative in the UK", *Critical Perspective on Accounting*, Vol. 14 No. 1, pp. 23-48.

Brown, L. D. and Moore, M. M. (2001), "Accountability, strategy and international nongovernmental organizations", *Nonprofit and Voluntary Sector Quarterly*, Vol. 30 No. 3, pp. 569-587.

Burritt, R. and Saka, C. (2006), "Quality of Physical Environmental Management Accounting Information - Lessons from Pollutant Release and Transfer Registers", in Schaltegger, S., Bennett, M. and Burritt, R. (Eds.), *Sustainability Accounting and Reporting*. Springer, pp. 373-407.

Canning, M., O'Dwyer, B. and Georgakopoulos, G. (2018), "Processes of auditability in sustainability assurance – the case of materiality construction", *Accounting and Business Research*, Vol. 49 No. 1, pp. 1-27.

Cañón-de-Francia, J., Garcés-Ayerbe, C. and Ramírez-Alesón, M. (2008), "Analysis of the effectiveness of the first European Pollutant Emission Register (EPER)", *Ecological Economics*, Vol. 67 No. 1, pp. 83-92.

Cho, C. H., Freedman, M. and Patten, D. M. (2012), "Corporate disclosure of environmental capital expenditures: A test of alternative theories", *Accounting, Auditing & Accountability Journal*, Vol. 25 No. 3, pp. 486-507.

Cho, C. H., Guidry, R. P., Hageman, A. M. and Patten, D. M. (2012), "Do actions speak louder than words? An empirical investigation of corporate environmental reputation", *Accounting, Organizations and Society*, Vol. 37 No. 1, pp. 14-25.

Cho, C. H., Roberts, R. W. and Patten, D. M. (2010), "The language of US corporate environmental disclosure", *Accounting, Organizations and Society*, Vol. 35 No. 4, pp. 431-443.

Comyns, B. and Figge, F. (2015), "Greenhouse gas reporting quality in the oil and gas industry - A longitudinal study using the typology of "search", "experience" and "credence" information", *Accounting, Auditing and Accountability Journal*, Vol. 28 No. 3, pp. 403-433.

Cooper, N., Green, D. and Meissner, K. J. (2017), "The Australian National Pollutant Inventory Fails to Fulfil Its Legislated Goals", *International Journal of Environmental Research and Public Health*, Vol. 14 No. 5, pp. 478-496.

Crump, K. S., Kjellstrom, T., Shipp, A. M., Silvers, A. and Stewart, A. (1998), "Influence of prenatal mercury exposure upon scholastic and psychological test performance: Benchmark analysis of a New Zealand cohort", *Risk Analysis*, Vol. 18, pp. 701-713.

Deegan, C. (2013), "The accountant will have a central role in saving the planet … really? A reflection on 'green accounting and green eyeshades twenty years later'", *Critical Perspectives on Accounting*, Vol. 24 No. 6, pp. 448-458.

Deegan, C. and Rankin, M. (1997), "The materiality of environmental information to users of annual reports ", *Accounting, Auditing & Accountability Journal*, Vol. 10 No. 4, pp. 562-583.

Delone, W. H. and McLean, E. R. (1992), "Information systems success: the quest for the dependent variable", *Information systems research*, Vol. 3 No. 1, pp. 60–95.

Dey, C. (2007), "Developing silent and shadow accounts", in Unerman, J., Bebbington, J. and O'Dwyer, B. (Eds.), *Sustainability Accounting and Accountability*. Routledge, Oxon, pp. 307-326.

Dutt, U., Nelson, P. F., Morrison, A. L. and Strezov, V. (2009), "Mercury wet deposition and coal-fired power station contributions: An Australian study", *Fuel Processing Technology*, Vol. 90 No. 11, pp. 1354-1359.

FASB. (1980), "Statement of Financial Accounting Concepts No. 2: Qualitative Characteristics of Accounting Information", Financial Accounting Standards Board of the Financial Accounting Foundation, Connecticut, USA.

Floridi, L. and Illari, P. (2014), "Introduction", in Floridi, L. and Illar, P. (Eds.), *The Philosophy of Information Quality*. Springer, London, UK, pp. 1-4.
Fontana, A. and Frey, J. (2000), *The Interview: From Structured Questions to Negotiated Text*, Sage, Thousand Oaks, California.
Fung, A. and O'Rourke, D. (2000), "Reinventing Environmental Regulation from the Grassroots Up: Explaining and Expanding the Success of the Toxics Release Inventory", *Environmental Management*, Vol. 25 No. 2, pp. 115-127.
Garcia, J., Sterner, T. and Afsah, S. (2007), "Public disclosure of industrial pollution: The PROPER approach for Indonesia?", *Environment and Development Economics*, Vol. 12, pp. 739-756.
Gentles, S. J., Charles, C., Ploeg, J. and McKibbon, K. (2015), "Sampling in Qualitative Research: Insights from an Overview of the Methods Literature", *The Qualitative Report*, Vol. 20 No. 11, pp. 1772-1789.
Gerde, V. W. and Logsdon, J. M. (2001), "Measuring environmental performance: use of the Toxics Release Inventory (TRI) and other US environmental databases", *Business Strategy and the Environment*, Vol. 10 No. 5, pp. 269-285.
Gill, G. S. (1983), "True and fair view", *The Australian Accountant*, Vol. 1983 No. November, pp. 701-703.
Goodhue, D. L. (1995), "Understanding user evaluations of information systems", *Management Science*, Vol. 41 No. 12, pp. 1827–1844.
Gray, R. (2005), "Taking a Long View of What we now Know About Social and Environmental Accountability and Reporting", *Electronic Journal of Radical Organisation Theory*, Vol. 9 No. 1, pp. 3-36.
Gray, R. (2010), "Is accounting for sustainability actually accounting for sustainability. . .and how would we know? An exploration of narratives of organisations and the planet", *Accounting, Organisations and Society*, Vol. 35 No. 1, pp. 47-62.
Gray, R. and Milne, M. (2004), "Towards Reporting on the Triple Bottom Line: Mirages, Methods and Myths", in Henriques, A. and Richardson, J. (Eds.), *The Triple Bottom Line: Does it All Add Up?* Earthscan, London, pp. 70-80.
Gray, R. H., Owen, D. L. and Adams, C. (1996), *Accounting and Accountability: Social and environmental accounting in a changing world*, Prentice Hall International, Hemel Hempstead.
GRI. (2011), "Sustainability Reporting Guidelines", in *Defining Report Content, Quality, and Boundary*. Global Reporting Initiatives, Amsterdam, The Netherlands pp. 7-17.
Guthrie, J. and Parker, L. D. (1990), "Corporate social disclosure practice: a comparative international analysis", *Advances in Public Interest Accounting*, Vol. 3 No. 1, pp. 159-175.
Guthrie, J. and Parker, L. D. (2016), "Whither the accounting profession, accountants and accounting researchers", *Accounting, Auditing & Accountability Journal*, Vol. 29 No. 1, pp. 2-10.
Guthrie, J. and Parker, L. D. (2017), "Reflections and projections", *Accounting, Auditing & Accountability Journal*, Vol. 30 No. 1, pp. 2-17.
Ha˛bek, P. and Wolniak, R. (2016), "Assessing the quality of corporate social responsibility reports: the case of reporting practices in selected European Union member states ", *Quality & Quantity: International Journal of Methodology*, Vol. 50, pp. 399–420.
Haslam, C., Butlin, J., Andersson, T., Malamatenios, J. and Lehman, G. (2014), "Accounting for carbon and reframing disclosure: A business model approach", *Accounting Forum*, Vol. 38 No. 3, pp. 200-211.
Hazelton, J. (2015), "Developments in Corporate Water Accounting and Accountability", in Crowther, D. and Islam, M. A. (Eds.), *Sustainability After Rio (Developments in Corporate Governance and Responsibility)*. Emerald Group Publishing, The UK, pp. 27-55.
Helfaya, A., Whittington, M. and Alawattage, C. (2019), "Exploring the quality of corporate environmental reporting: Surveying preparers' and users' perceptions", *Accounting, Auditing & Accountability Journal*, Vol. 32 No. 1, pp. 163-193.
Hess, D. (2007), "Social reporting and new governance regulation: the prospects oe achieving corporate accountability through transparency", *Business Ethics Quarterly*, Vol. 17 No. 3, pp. 453-476.
Howes, M. (2010), "What's Your Poison? The Australian National Pollutant Inventory versus the US Toxics Release Inventory", *Australian Journal of Political Science*, Vol. 36 No. 3, pp. 529-552.
Hylander, L. D. and Meili, M. (2003), "500 years of mercury production: global annual inventory by region until 2000 and associated emissions", *Science of The Total Environment*, Vol. 304 No. 1-3, pp. 13-27.
Ippolito, S. J., Sabri, Y. M. and Bhargava, S. K. (2012), "Measuring Gas Phase Mercury Emissions from Industrial Effluents", in Liu, G., Cai, Y. and O'Driscoll, N. (Eds.), *Environmental Chemistry and Toxicology of Mercury*. John Wiley & Sons, Inc., United States of America, pp. 59-109.
Ismawati, Y., Zaki, K., Buftheim, S., Septiono, M. A. and Arif, A. S. (2017), "Mercury trade and supply in Indonesia", in. BaliFokus and Ban Toxics!, Jakarta, Indonesia.
Jarke, M. and Vassiliou, Y. (1997), "Data warehouse quality: a review of the DWQ project", in *Conference on Information Quality*, Cambridge, MA, pp. 299–313.

Kolominskas, C. and Sullivan, R. (2004), "Improving cleaner production through pollutant release and transfer register reporting processes", *Journal of Cleaner Production*, Vol. 12 No. 7, pp. 713-724.
Lee, Y., Strong, D., Kahn, B. and Wang, R. (2002), "AIMQ - a methodology for information quality assessment", *Information & Management*, Vol. 40 No. 2, pp. 133-146.
Leong, S. and Hazelton, J. (2019), "Under what conditions is mandatory disclosure most likely to cause organisational change?", *Accounting, Auditing & Accountability Journal*, Vol. 32 No. 3, pp. 811-835.
Lloyd-Smith, M. (2008), "Australia's National Pollutant Inventory - has it served community right to know?", in *National Pollutant Inventory Conference 2008*, ANU House, Canberra, ACT.
Marshall, B., Cardon, P., Poddar, A. and Fontenot, R. (2013), "Does sample size matter in qualitative research: a review of qualitative interviews in IS research", *Journal of Computer Information Systems*, Vol. 54 No. 1, pp. 11-22.
Mathews, M. R. (1997), "Twenty-five years of social and environmental accounting research Is there a silver jubilee to celebrate?", *Accounting, Auditing & Accountability Journal*, Vol. 10 No. 4, pp. 481-531.
Miller, P. B. W. and Bahnson, P. R. (2003), "Out of sight, out of mind: destroying accountability", *Accounting Today*. SourceMedia, Inc., New York, p. 14.
Miller, P. B. W. and Bahnson, P. R. (2007), "The top 10 reasons to fix the FASB's conceptual framework", *Strategic Finance*, Vol. 89 No. 1, pp. 43-49.
Mohapatra, S. P., Nikolova, I. and Mitchell, A. (2007), "Managing Mercury in the Great Lakes: An Analytical Review of Abatement Policies", *Journal of Environmental Management*, Vol. 83 No. 1, pp. 80-92.
Moses, O., Mohaimen, F. J. and Emmanuel, M. (2020), "A Meta-Review of SEAJ: The Past and Projections for 2020 and Beyond", *Social and Environmental Accountability Journal*, Vol. 40 No. 1, pp. 24-41.
Nelson, P. F. (2007), "Atmospheric emissions of mercury from Australian point sources", *Atmospheric Environment*, Vol. 41 No. 8, pp. 1717-1724.
Nelson, P. F., Morrison, A. L., Malfroy, H. J., Cope, M., Lee, S., Hibberd, M. L., Meyer, C. P. and McGregor, J. (2012), "Atmospheric mercury emissions in Australia from anthropogenic, natural and recycled sources", *Atmospheric Environment*, Vol. 62, pp. 291-302.
Nelson, P. F., Nguyen, H., Morrison, A. L., Malfroy, H., Cope, M. E., Hibberd, M. F., Lee, S., McGregor, J. L. and Meyer, M. C. (2009), "Mercury Sources, Transportation and Fate in Australia", in *Final Report to the Department of Environment, Water, Heritage & the Arts*. Department of Environment, Water, Heritage & the Arts, pp. 1-183.
NEPC. (2018), "Review of the National Pollutant Inventory", National Environment Protection Council, Australia.
NEPC. (2019), "Annual Report 2017-18", available at: http://www.nepc.gov.au/system/files/resources/1ed358dc-9aee-442f-9821-78ce95bf20a6/files/nepc-annual-report-2017-18.pdf (accessed 13 June 2020).
NPI. (2014), "Mercury & compounds ", available at: http://www.npi.gov.au/resource/mercury-compounds (accessed 14 June 2014).
NPRI. (2017), "National Pollutant Release Inventory (NPRI) - Data Quality Management Framework", available at: https://www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=23EAF55A-1 (accessed May 1 2017).
NRC. (2000), *Toxicological Effects of Methylmercury*, National Academy Press, Washington, DC.
O'Dwyer, B. (2004), "Qualitative Data Analysis: Illuminating a Process for Transforming a 'Messy' but 'Attractive' 'Nuisance'", in Humphrey, C. and Lee, B. (Eds.), *The Real Life Guide to Accounting Research: A Behind the Scenes View of Using Qualitative Research Methods*. Elsevier, Oxford, UK.
O'Dwyer, B. and Boomsma, R. (2015), "The co-construction of NGO accountability", *Accounting, Auditing and Accountability Journal*, Vol. 28 No. 1, pp. 36 - 68.
O'Dwyer, B., Unerman, J. and Hession, E. (2005), "User needs in sustainability reporting: Perspectives of stakeholders in Ireland", *European Accounting Review*, Vol. 14 No. 4, pp. 759-787.
O'Dwyer, B., Owen, D. and Unerman, J. (2011), "Seeking legitimacy for new assurance forms: The case of assurance on sustainability reporting", *Accounting, Organizations and Society*, Vol. 36 No. 1, pp. 31-52.
OECD. (2008), "Considerations for Ensuring Quality PRTR Data", *Series on Pollutant Release and Transfer Registers*. OECD, Paris, pp. 1-46.
Økelsrud, A., Lydersen, E. and Fjeld, E. (2016), "Biomagnification of mercury and selenium in two lakes in southern Norway", *Science of The Total Environment*, Vol. 566-567, pp. 596-607.
Økelsrud, A., Lydersen, E., Moreno, C. and Fjeld, E. (2017), "Mercury and selenium in free-ranging brown trout (Salmo trutta) in the River Skienselva watercourse, Southern Norway", *Science of The Total Environment*, Vol. 586, pp. 188-196.
Power, S. (Undated), "Environmental law review", available at: https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/BriefingBook46p/EnvironmentalLaw (accessed 13 June 2020).

Rahman, J. (2011), "A Review of Coastal Pollution and Its Impact on Childhood Disability and Pregnancy Outcome: A Case Study in the Coastal Area of Bangladesh ", Master of Public Health (Global Health), Thammasat University.
Ritchie, J., Lewis, J. and Elam, G. (2003), "Designing and Selecting Samples", in Ritchie, J. and Lewis, J. (Eds.), *Qualitative Research Practice - A Guide for Social Science Students and Researchers*. Sage Publications Ltd, London, The UK, pp. 77-108.
Ryan, G. and Bernard, H. R. (2000), "Data Management and Analysis Methods", in Denzin, N. and Lincoln, Y. (Eds.), *Handbook of Qualitative Research*. Sage, Thousand Oaks, California, pp. 769–802.
Samkin, G., Schneider, A. and Tappin, D. (2014), "Developing a reporting and evaluation framework for biodiversity", *Accounting, Auditing & Accountability Journal*, Vol. 27 No. 3, pp. 527-562.
Selin, H. (2013), "The Minamata Convention and the Future of Mercury Abatement", in *Pardee Center Issue in Brief*. Boston University, Boston University: The Frederick S. Pardee Center for the Study of the Longer-Range Future.
Selin, N. E. and Selin, H. (2006), "Global Politics of Mercury Pollution: The Need for Multi-Scale Governance", *Review of European Community & International Environmental Law*, Vol. 15 No. 3, pp. 258-269.
Shannon, C. and Weaver, W. (1964), "The mathematical theory of communication", available at: https://pure.mpg.de/rest/items/item_2383164/component/file_2383163/content (accessed 16 September 2020).
Shiqiu, Z. (2014), "Improving Government Accountability in the Face of Environmental Challenges", in Jianqiang, L. (Ed.), *Chinese Research Perspectives on the Environment: Public Action and Government Accountability*. BRILL, pp. 57-68.
Sinclair, A. (1995), "The chameleon of accountability: forms and discourses", *Accounting, Organizations & Society*, Vol. 20 No. 2/3, pp. 219-237.
Stanwick, P. A. and Stanwick, S. D. (2006), "Environment and Sustainability Disclosures: A Global Perspective on Financial Performance", in Allouche, J. (Ed.), *Corporate Social Responsibility* Palgrave Macmillan, New York.
Stephan, M. (2002), "Environmental Information Disclosure Programs: They Work But Why?", *Social Science Quarterly*, Vol. 83 No. 1, pp. 190-205.
Strezov, V., Evans, T., Ziolkowski, A., Shah, P. and Nelson, P. F. (2010), "The Effect of Reducing Conditions and Temperature on Mercury Release from Coal", *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, Vol. 32 No. 18, pp. 1712-1719.
Tang, M. and Mudd, G. M. (2015), "The pollution intensity of Australian power stations: a case study of the value of the National Pollutant Inventory (NPI)", *Environ Sci Pollut Res Int*, Vol. 22 No. 23, pp. 18410-18424.
Tchounwou, P. B., Yedjou, C. G., Patlolla, A. K. and Sutton, D. J. (2014), "Heavy Metals Toxicity and the Environment", available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4144270/pdf/nihms414261.pdf (accessed January 2 2019).
Tello, E., Hazelton, J. and Cummings, L. (2016), "Potential users' perceptions of general purpose water accounting reports", *Accounting, Auditing & Accountability Journal*, Vol. 29 No. 1, pp. 80-110.
Telmer, K. H. and Veiga, M. M. (2009), "World emissions of mercury from artisanal and small scale gold mining", in Pirrone, N. and Mason, R. (Eds.), *Mercury Fate and Transport in the Global Atmosphere* Springer Science, New York, pp. 131-172.
Tregidga, H. (2013), "Biodiversity offsetting: problematisation of an emerging governance regime", *Accounting, Auditing & Accountability Journal*, Vol. 26 No. 5, pp. 806–832.
Trotter, R. T. (2012), "Qualitative research sample design and sample size: Resolving and unresolved issues and inferential imperatives", *Preventive Medicine*, Vol. 55 No. 5, pp. 398–400.
UN Environment. (2017), "Global mercury supply, trade and demand", United Nations Environment Programme, Chemicals and Health Branch, Geneva, Switzerland.
UN Environment. (2019), "Global Mercury Assessment 2018", United Nations Environment Programme, Chemicals and Health Branch, Geneva, Switzerland.
UNEP. (2011), "Study on the possible effects on Human Health and the Environment in Asia and the Pacific of the trade of products containing Lead, Cadmium and Mercury", Division of Technology, Industry and Economics (DTIE) Chemicals Branch, Geneva, Switzerland.
UNEP. (2013a), "Global Mercury Assessment 2013 : Sources, Emissions, Releases and Environmental Transport", UNEP Chemicals Branch, Geneva, Switzerland, pp. 1-44.
UNEP. (2013b), "The Minamata Convention on Mercury", United Nations Environment Programme, Nairobi, Kenya.
UNEP. (2018), "The Minamata Convention on Mercury", available at: http://www.mercuryconvention.org/Countries/Parties/tabid/3428/language/en-US/Default. aspx (accessed 14 June 2018).

Unerman, J., Bebbington, J. and O'dwyer, B. (2018), "Corporate reporting and accounting for externalities", *Accounting and Business Research*, Vol. 48 No. 5, pp. 497-522.
Unerman, J. and Chapman, C. (2014), "Academic contributions to enhancing accounting for sustainable development", *Accounting, Organizations and Society*, Vol. 39 No. 6, pp. 385-394.
USEPA. (1997), "Mercury Study Report to Congress", in United States Environmental Protection Agency (Ed.). Office of Air Quality Planning and Standards and Office of Research and Development.
USEPA. (2014), "Mercury: Basic Information", available at: http://www.epa.gov/mercury/about.htm (accessed 2 June 2014).
Valera, B., Dewailly, E. and Poirier, P. (2011), "Impact of Mercury Exposure on Blood Pressure and Cardiac Autonomic Activity among Cree Adults (James Bay, Quebec, Canada)", *Environmental Research*, Vol. 111 No. 8, pp. 1265-1270.
Walcek, C., De Santis, S. and Gentile, T. (2003), "Preparation of mercury emissions inventory for eastern North America", *Environmental Pollution*, Vol. 123 No. 3, pp. 375-381.
Wand, Y. and Wang, R. Y. (1996), "Anchoring data quality dimensions in ontological foundations", *Communications of the ACM*, Vol. 39 No. 11, pp. 86–95.
Wang, R. Y. and Strong, D. M. (1996), "Beyond accuracy: what data quality means to data consumers", *Journal of Management Information Systems*, Vol. 12 No. 4, pp. 5–34.
Weihe, P., Grandjean, P. and Jogensen, P. J. (2005), "Application of Hair-Mercury Analysis to Determine the Impact of a Seafood Advisory", *Environmental Research*, Vol. 97 No. 2, pp. 201–208.
WHO. (2017), "Mercury and health", available at: https://www.who.int/news-room/fact-sheets/detail/mercury-and-health (accessed 14 June 2020).
Williams, T. H. and Griffin, C. H. (1969), "On the nature of empirical verification in accounting", *Abacus*, Vol. 5 No. 2, pp. 143-178.
Wolk, H. I., Dodd, J. L. and Rozycki, J. J. (2013), *Accounting Theory: Conceptual Issues in a Political and Economic Environment*, SAGE Publications, Inc.
Yorifuji, T., Tsuda, T. and Harada, M. (2012), "Minamata Disease: Catastrophic food poisoning by methylmercury and a challenge for democracy and justice", in TKTK (Ed.), *Late Lessons From Early Warnings-2012 Science, Precaution, Innovation*. European Environment Agency, pp. 63-99.
Zhao, J. and Ortolano, L. (2003), "The Chinese Government's Role in Implementing Multilateral Environmental Agreements - The Case of the Montreal Protocol", *The China Quarterly*, Vol. 175 No. 3, pp. 708-725.
Zmud, R. (1978), "Concepts, theories and techniques: an empirical investigation of the dimensionality of the concept of information", *Decision Sciences*, Vol. 9 No. 2, pp. 187–195.
Zuo, A. and Wheeler, S. A. (2019), "Maximising the use of national pollution data: Views from stakeholders in Australia", *Journal of Cleaner Production*, Vol. 222, pp. 455-463.

Tables

Table 1. – Prior studies utilising qualitative characteristics in relation to environmental reporting

	Sources	**Qualitative characteristics used**
1	Helfaya *et al.* (2019)	Completeness, accuracy, and reliability
2	Unerman *et al.* (2018)	Multipe (comparison of eighteen charactersistcs across major sustainabilty reporting standards)
3	Haˬbek and Wolniak (2016)	Multiple (seventeen criteria utilised, including redeability, feedback and verifiability classified under relevance and credibility)
4	Comyns and Figge (2015)	Accuracy, completeness, consistency, credibility, relevance, timeliness, and transparency (transparency, reliability, and clarity)
5	Ane (2012)	Relevance, reliance, comparability, and clarity
6	Stanwick and Stanwick (2006)	Auditability, completeness, relevance, accuracy, neutrality, comparability, timeliness, transparency, inclusiveness, clarity, and context
7	Burritt and Saka (2006)	Understandability, relevance, materiality, reliability (faithful representation, substance over form, neutrality, prudence, completeness), comparability, timeliness, and balance between benefit and cost
8	O'Dwyer *et al.* (2005)	Adequacy, verifiability, credibility, comparability, consistency, and usefulness

Source: compiled by authors

Table 2 - Academic views of information quality (IQ)

	Intrinsic IQ	**Contextual IQ**	**Representational IQ**	**Accessibility IQ**
Wang and Strong (1996)	Accuracy, believability, reputation, objectivity	Value-added, relevance, completeness, timeliness, appropriate amount	Understandability, interpretability, concise representation, consistent representation	Accessibility, ease of operations, security
Zmud (1978)	Accurate, factual	Quantity, reliable/timely	Arrangement, readable, reasonable	
Jarke and Vassiliou (1997)	Believability, accuracy, credibility, consistency, completeness	Relevance, usage, timeliness, source currency, data warehouse currency, non-volatility	Interpretability, syntax, version control, semantics, aliases, origin	Accessibility, system availability, transaction availability, privileges
Delone and McLean (1992)	Accuracy, precision, reliability, freedom from bias	Importance, relevance, usefulness, informativeness, content, sufficiency, completeness, currency, timeliness	Understandability, readability, clarity, format, appearance, conciseness, uniqueness, comparability	Usableness, quantitativeness, convenience of access
Goodhue (1995)	Accuracy, reliability	Currency, level of detail	Compatibility, meaning, presentation, lack of confusion	Accessibility, assistance, ease of use, locatability
Ballou and Pazer (1985)	Accuracy, consistency	Completeness, timeliness		
Wand and Wang (1996)	Correctness, unambiguous	Completeness	Meaningfulness	

Source: Reproduced from Lee, et al. (2002, p. 134)

Table 3 - Overview of submissions to the Review of the National Pollutant Inventory (2018)

Submission length (pages)	Number of responses
20+	1
15-19	2
10-14	9
5-9	11
3-4	15
2	10
1	6
Total	54

Source: compiled by authors

Table 4 - Overview of interviews

Interview	**Duration (mins)**	**Type**	**Interviewee (s)**	**Role**
1	93	Face to Face	Interviewee -1	Researcher
2	71	Face to Face	Interviewee -2 Interviewee -3	UNEP Mercury Experts
3	66	Telephone	Interviewee -4 Interviewee -5	Regulator Regulator
4	75	Telephone	Interviewee -6 Interviewee -7	Regulator Regulator
5	66	Telephone	Interviewee -8	Regulator
6	47	Telephone	Interviewee -9	Corporate Reporter
7	40	Telephone	Interviewee -10	Regulator
8	81	Telephone	Interviewee -11	Regulator
9	85	Videoconference	Interviewee -12	Corporate Reporter
10	69	Videoconference	Interviewee -13	Corporate Reporter
	Total = 693 Minutes, Average = 69 Minutes			

Table 5 – References to reporting quality elements in 2018 NPI inquiry submissions

Reporting Quality Element	References	
	#	%
Understandability	26	48%
Timeliness	22	41%
Accuracy	39	72%
Comparability	27	50%
Verifiability	20	37%
Completeness	21	39%
Funding/Resources	27	50%
Total submissions	54	

Source: compiled by authors

Table 6 – Auditing of NPI data

State	**Reports lodged (2016-17)**	**Desktop audits**	**On-site audits**	**Regulatory actions**
NSW	899	899	Not disclosed	Not disclosed
VIC	824	181	6	0
QLD	858	442	2	0
WA	813	813	11	0
SA	479	479	0	0
Tasmania	150	150	0	0
ACT	21	21	0	0
NT	101	14	0	0
Total	**4044**	**2985**	**19**	**0**
Total %		**73.8%**	**0.5%**	**0%**

Source: NEPC (2019, pp. 180-190)